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Air Ambulance Services Transport of Critically Sick Patients

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Transport of critically sick patients has always remained a challenge since time immemorial. The sick used to be carried by surface ambulances from the war zones to military hospitals and primary to tertiary care centres causing significant increase in morbidity and mortality. Most of the times transport by surface ambulance was not possible due to shear logistical nightmare of time involved, non availability of critical care equipments for such a long duration and deterioration of patients during transport. The excessive morbidity and mortality of soldiers during wars lead to the concept of air ambulance services for saving valuable lives and decreasing morbidity. The first recorded use of an aircraft for evacuation of soldiers was during the first world war when an Italian soldier who required amputation of both legs in a remote war zone with no medical facilities was evacuated to tertiary care centre on a flight taking 3 hours, while the surface journey would have taken 6 days to reach the same hospital. With increasing requirement of transferring patients to save life and provide best medical care, Air medevac has become a part of the emergency medical services system.

There is need to provide comprehensive emergency and critical care to all types of patients during rescue operations aboard helicopter or fixed wing aircrafts. The services are extremely advanced ICU in air and life saving for many who are evacuated from extremely hostile terrains and remote places completely devoid of medical facilities.

HISTORY OF AIR AMBULANCE SERVICES

The helicopters for use of Medevac dates back to use in Burma in 1944 and subsequently in the prolonged and bloody war of Vietnam and US. The first fixed wing aircraft was used in world war for an Italian patient in 1917 but well equipped air ambulances were used during second world war, where the air ambulances were used not only for transfer of patients to the hospital but also for in flight treatment and minor surgeries performed in the air. Obviously it was use during wars and requirement to transfer patients from hostile war zones to safe havens of tertiary care hospitals was instrumental in developing the concept of air ambulance services which was logically extended to civilian populations. The use has expanded to a fully equipped ICU in the air with all modalities of treatments being given in Air and patients being transferred on ventilators, pacemakers and aortic balloon pumps. Advanced countries like Switzerland have air ambulance services not only for human beings but for injured animals specially cows.

POTENTIAL RISKS AND CHALLENGES DURING AIR AMBULANCE TRANSFERS

Atmospheric/ Avionic Physics

Atmospheric physics potentially affect all air travellers regardless of the aircraft and more so the patients being evacuated in compromised status. As planes ascend through the first 30,000–40,000 feet, the temperature decreases linearly at an average rate of 2°C/ 305 m. If sea-level temperature is 16°C, the outside air temperature is approximately −57°C at 35,000 feet. Pressure and humidity also decline, and patients are also exposed to radiation, vibration and acceleration forces also known as "g" forces. Cabin humidity usually ranges from 10 to 20 % and this is completely unavoidable as air at high altitude is completely devoid of humidity. It causes drying effect on airway passages, skin and cornea specially those using contact lenses. Demons and Cook monitored anxiety levels of patients and noted that anxiety levels are usually very high in anticipation of the flight and possible outcome due to non availability of standard medical care during periods of difficulties or complications.

Pressurization of Aircrafts

There are special issues with respect to pressurization of the aircraft. Not all aircraft and helicopters used as air ambulances have pressurized cabins, and others are pressurized to only 10,000 feet above sea level. In many case the flight need to be operated at pressures maintained at sea levels when flying at 15000 feet. These pressure changes require advanced knowledge by flight staff with respect to the specifics of aviation medicine, including changes in physiology and the behaviour of gases. There are effects of gas expansion at higher altitudes, the effect of hypoxia and anxiety, potential for complications during movement of patients. The helicopters have stricter weather conditions that they can operate in and commonly do not fly at altitudes over 10,000 feet above sea level. We need to discover and prevent various adverse physiological responses to hostile biologic and physical stresses encountered in the aerospace environment.

Hypoxia at high altitude

Hypoxia can be an extremely serious issue during Medevacs. Fixed wings propeller aircrafts fly at 15000 feet while jets fly at35-40000 feet above the sea levels. Barometric pressure progressively decreases from 760 mm of Hg at sea level to140 mm of Hg at 40,000 feet. Partial pressure of inspired oxygen decreases proportionately to increasing altitude. Since the water vapour pressure

at normal body temperature is 47 mm of Hg regardless of altitude, PiO_2 at 40,000 feet is incompatible with human life. In order for humans to fly at such altitudes the aircrafts are pressurised at 8-10,000 feet levels. PiO_2 decreases from 150mm of Hg at Sea level to 107 mm of Hg at cabin pressure of 8,000 feet. For a normal traveller it causes decrease of PaO_2 from 98 to 55mmof Hg and leads to a small decrease in Oxygen saturation but in a compromised patient with cardio-pulmonary disorder, it could lead to significant drop of oxygen saturation requiring the patient to be flown in air ambulance with Cabin pressures reduced to sea levels, which is not only very expensive but technically very difficult to maintain and very few air ambulances are equipped to handle this technically and operationally.

The physiologic response to decreased PiO_2 is hyperventilation, caused by increase in the tidal volume and increased cardiac output caused primarily due to tachycardia. This increase in cardiac output is proportional to drop in oxygen saturation. Hypoxia is also a stimulus for atrial arrhythmias and premature ventricular beats. The increased sympathetic nervous system activity during air ambulance flights is additional factor predisposing to cardiac arrhythmias.

Expansion of Gases at high altitude

We have all studied Boyel's law during our class 12 which states that the volume to which a given quantity of gas is compressed is inversely proportional to surrounding pressures. Any gas trapped in an enclosed space expands by 40 percent going from sea level to 10 thousand feet of altitude. It can potentially cause severe pain and perforation of ear drums if Eustachian tubes are blocked or stretching of suture lines after recent abdominal surgeries. This is a definite concern in patients of pneumothorax as the expansion of gases cause desaturation or hemodynamic compromise if it becomes tension pneumothorax. Expansion of gasses in hollow obstructed viscera may expand and cause rupture of viscera. Air in endotracheal tubes expands and may cause trauma to the trachea, requiring adjustments in the cuff pressure. We need to use IV bags rather than bottles as expanded gas in the bottles can increase the flow rates and if medicines are included than overmedication may happen. There is a need to use infusion pumps rather than open line to control the doses of critical medications and the quantity of fluids being administered.

Aircraft life support systems such as oxygen, heat and pressurization are the first line of defence against most of the hostile aerospace environment. Higher performance aircraft will provide more sophisticated life support equipment to help the body resist acceleration, and pressure breathing apparatus. In compromised patients there is elevation in risk of sudden incapacitation, such as a tendency towards myocardial infarction, epilepsy or worsening of diabetes and expansion of abdominal and pulmonary gases which may lead to hazardous condition at higher altitude. Barodontalgia, commonly known as tooth squeeze and previously known as aerodontalgia, is pain in tooth caused by a change in atmospheric pressure. The pain usually ceases at ground.

Operational challenges

Availability of Planes/helicopters is not a problem but in absence of dedicated air ambulance, different types of planes are chartered hence the compatibility of equipment and the stability during the flights can be a problem especially during turbulences. Different configuration and types of planes don't provide similar space and equipment handling comfort. Oxygen supply when not available in standard fit cylinders causes need to carry additional oxygen bottles against the rules of flight safety which needs fixed oxygen cylinders. Where the service provider company has a dedicated plane for air ambulance services, the compatibility of equipment and fixed oxygen is not a problem The conversion time of plane to air ambulance decreases and compatibility of equipment and safety is ensured. The dedicated aircraft can be converted from a chartered plane to Air Ambulance in 45 minutes time while more time may be required sometimes for organizing various other permissions.

Equipment and interiors

Air ambulances, are equipped for advanced life support and have interiors that reflect this. The challenges in most air ambulance operations, particularly those involving helicopters, are the high ambient noise levels and limited amount of working space, both of which create significant issues for the provision of ongoing care. While equipment tends to be high-level and very conveniently grouped, it may not be possible to perform some assessment procedures while in flight. In some types of aircraft, the design means that the entire patient is not physically accessible in flight.

The specialized stretchers where all equipment can be secured and stability with oxygen supply are imported and very expensive as very few companies in the world are manufacturing them. Special patient loading equipment, vacuum mattresses, ventilators driven by oxygen only, IV fluid dispensing equipment, monitors, defibrillators, syringe and infusion pumps need to be fully secured with the stretcher to avoid instability during turbulences, so are specially made for Air ambulance hence more expansive. A typical air ambulance is a complete ICU in the air. Specialized ambulances also carry aortic balloon pumps.

Accidents

Beginning in the 1990s, the number of air ambulance crashes in the United States mostly involving helicopters, began to climb. By 2005, this number had reached a record high because when a life was at stake, air ambulances would often operate on the very edge of their safety envelopes, going on missions in conditions where no other civilian pilot would fly. These pilots must have a great deal of experience in piloting the aircraft because the conditions of air ambulance flights are often more challenging. After a spike in air ambulance crashes in the United States, the U.S. government stepped up the

accreditation and air ambulance flight requirements, ensuring that all pilots, personnel, and aircraft meet higher standards.

In 2006, the United States National Transportation Safety Board concluded that many air ambulances crashes were avoidable eventually leading to the improvement of government standards and CAMTS accreditation. Many crashes were due to extreme weather conditions and trying to save lives but were counterproductive as many lives of crew, medical professionals and patients on board were lost.

Air Fields and Landing requirements: Non-availability of helicopter landings even in the major metros and towns make the service nonexistent in our country for serious emergencies as the helicopter evacs are quite common all over the world. Many of the remote areas are not having operational air fields or require military clearances if some are available. Majority of the airfields are dawn to dusk hence the availability is limited during those hours leading to loss of crucial time. Regulations being nonexistent for medevac, the flight clearances can take enormous time and the staff in many small airfields are available for few hours as they cater to occasional flights. Poor communication facilities in those area cause enormous delays in acquiring permissions. Military control of airfields can cause many hours of delay for security clearances especially when foreign nationals are involved or in high security operational area.

Medical Personnel

In most cases, an air ambulance staff has to be considerably more skilled than a typical paramedic so as to permit them to exercise more medical decision-making attitude. Assessment skills need to be considerably higher, and permit inclusion of functions such as reading x-rays, scans and interpretation and performance of critical and important lab results. This allows for planning, consultation with supervising physicians, and issuing contingency orders during flight. In seriously ill patients the inclusion of respiratory therapists/intensivists experienced in aviation medicine is becoming more prominent. They also need training in such areas such as intubation, chest tube insertion, surgical airways, securing patient cervical spine through use of spine boards in flight which can be very difficult due to lack of space and manoeuvrability.

Cost-effectiveness

The service is very cost effective if the value of life saved is calculated but remains prohibitively expensive in our country. Whilst some countries have effective methods of funding as in the UK and Europe the Insurance systems are available to make it cost effective. Most of European countries, US and Canada provide insurance for air evacuation during emergencies to travellers all over the world and this concept of insurance cuts down the cost of air evacuations especially for those who are travelling to remote areas for tourism or adventure sports. Emergencies during national disasters are covered mostly by government funds.

Despite of various challenges and nascent stage of air ambulance services in India, the service is growing and there is a need to kick start it for local populace by meeting all the challenges that can be overcome if the government of the day has the will, insurance companies start the services, the corporate pitch in their resources and charity starts contributing. The improvement of this industry can be a major boost to tourism and quality healthcare at right time in our country.

REFERENCES

1. Branas CC, MacKenzie EJ, Williams JC, Schwab CW, Teter HM, Flanigan MC et al. "Access to trauma centers in the United States.". *JAMA* 2005; 293:2626–33. doi:10.1001/jama.293.21.2626. PMID 15928284.
2. Burney RE, Hubert D, Passini L, Maio R "Variation in air medical outcomes by crew composition: a two-year follow-up." *Ann Emerg Med* 1995; 25:187–92. PMID 7832345.
3. Meier, B, Saul, S. Fatal crashes provoke debate on safety of sky ambulances. New York Times, February 28, 2005.
4. Isakov AP. "Souls on board: helicopter emergency medical services and safety.". *Ann Emerg Med* 2006;47:357–60. doi:10.1016/j.annemergmed.2005.12.020. PMID 16546621.
5. Lam DM. "To Pop A Balloon: Air Evacuation During The Siege of Paris, 1970." Aviation, Space, & Environmental Medicine, 59(10): 988-991, October 1988.
6. Bearl, Spc. Daniel. "MEDEVAC Unit Stays on Alert to Save Injured Comrades." US Military News via army.mil/-news, February 9, 2007. Retrieved: December 4, 2010.
7. "First in the Nation - Celebrating 37 Years of Air Medical Transport!" Flight for Life, 2006. 8 "Governor O'Malley Announces New Additions to Maryland's World-Class Emergency Response." Maryland State Police Aviation Command via mspaviation.org, October 20, 2010.